
**FACILITY DESCRIPTIONS
AND UPDATED COST ESTIMATES
FOR SHASTA LAKE ENLARGEMENT**

**Prepared by the CALFED Storage and Conveyance Refinement Team
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INTRODUCTION

The *Facility Descriptions and Updated Cost Estimates for Shasta Lake Enlargement* report has been prepared as part of the Storage and Conveyance Component Refinement Task of the CALFED Bay-Delta Program (CALFED or Program). CALFED's mission is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) system.

This report summarizes the principal features and estimated costs of enlarging the existing Shasta Dam and Reservoir from its present capacity of about 4.5 million acre-feet (maf) to about 14.3 maf. The general location of Shasta Lake is shown on Figure 1. This evaluation and others that are being performed by CALFED are intended to provide a facilities evaluation and updated cost estimates of representative storage and conveyance components. The objectives of the Shasta Lake Enlargement evaluation are (1) to provide an updated cost estimate which represents a cost within the range expected if the project were to be constructed today and (2) to enable CALFED to compare this project against other projects that might be considered as part of a long-term CALFED solution strategy.

The cost estimate for the Shasta Lake Enlargement was determined by escalating the costs in two reports: the September 1983 Bureau of Reclamation report entitled *Enlarged Shasta Lake Investigation--Preliminary Findings Report* and the February 1988 Bureau of Reclamation report entitled *Enlarging Shasta Lake Investigation--Office Report, Appendix 3*. The cost estimates performed by the Bureau of Reclamation in 1983 and in 1988 were reviewed and adopted for this evaluation; minor modifications were made to reflect current design and safety standards.

A preliminary evaluation of the environmental considerations associated with this proposed project has also been included in this report. Fish, wildlife, plant, and cultural resources that could be affected have been described and potential impacts have been identified. The

information for the evaluation of environmental considerations was gathered from existing literature.

PROJECT BACKGROUND

Development of the Sacramento River at the existing Shasta Dam was originally included as part of the State of California's State Water Plan of 1930. The original plans were enacted in the Central Valley Project Act, which called for Kennet Reservoir (now Shasta Lake) to be developed with a storage capacity of up to 2.9 maf. Development of the Central Valley Project (CVP), however, was not financially feasible for the state as a result of economic conditions during the Great Depression. Subsequently, federal authorization in 1935 through the Bureau of Reclamation provided for construction of the present Shasta Dam, which was completed in 1945.

Following the extreme drought of 1976 and 1977, Working Document No. 13, *Enlarging Shasta Lake* was prepared in November 1978 as part of the Total Water Management Study for the Central Valley Basin, California. That document addressed several alternative sizes and locations and concluded that enlargement of the existing structure to impound about 14.0 maf warranted further investigation.

Pursuant to the 1978 findings, the Bureau of Reclamation and the California Department of Water Resources (DWR) undertook followup studies of an enlarged Shasta Lake that resulted in a September 1983 Findings Report *Enlarged Shasta Lake Investigation, Shasta Division, CVP, California*. This report concluded that plan formulation for enlarging Shasta Lake to about 14.0 maf was warranted. The initial stages of plan formulation included a series of memoranda compiled by the Bureau of Reclamation and DWR in *Enlarging Shasta Lake Investigation*, Office Report, Appendix 3 (February 1988). Components of that report provide updates and expanded detail to the 1983 report, which together provide the basis for the present evaluation.

FACILITIES DESCRIPTION

This section provides an overview of the major features included in the proposed Shasta Lake enlargement report. The principal references used for this synopsis are the Bureau of Reclamation's 1983 Findings Report, *Enlarged Shasta Lake Investigation, Shasta Division, CVP, California* and the DWR's 1988 report, *Enlarging Shasta Lake Investigation, Office Report, Appendix 3.*

PROJECT LOCATION

The proposed enlargement of Shasta Dam would be located on the Sacramento River in Shasta County in northern California about 12 miles north of the City of Redding. The enlarged reservoir would be entirely within Shasta County; its water surface would extend farther into the reaches of the upper Sacramento, McCloud, and Pit Rivers (see Figure 2).

PROJECT DESCRIPTION

The primary purpose of enlarging Shasta Dam and Reservoir would be to reduce the frequency and magnitude of projected water shortages for various uses in the ~~Sacramento-San Joaquin Delta~~ by storing surplus winter and spring flows for release during dry seasons and years. According to previous investigations by the Bureau of Reclamation, an enlarged Shasta Lake would provide the following general benefits:

- **Reduced frequency and magnitude of water supply shortages.** The quantities of such reductions are dependent on operational strategies that have not yet been developed.

- **Increased power capacity and energy production.** Power plant capacity for the combined Shasta and Keswick facilities would be increased from 614 to 1,150 megawatts. Average annual energy production at the facilities could be increased by about 600 million kilowatt-hours.
- **Increased potential for flood protection.** Pending further investigation of flood control and emergency release criteria defined by the U.S. Army Corps of Engineers, additional flood space could be allocated and improved operational procedures could be developed.
- **Increased ability to manage downstream flows for fishery resources.** Additional storage and depth of water could provide greater opportunities to maintain suitable water temperatures and flow patterns in critical habitat reaches downstream of the dam.

The project operation would be coordinated with other existing and future State Water Project (SWP), CVP, and proposed CALFED facilities to enhance water supply opportunities. Changes in the storage and release of water from an enlarged Shasta Lake would depend on other activities of CALFED, the Central Valley Project Improvement Act, and evolving Bay-Delta Water Quality Standards. As these aspects of the operations are in the formative stages, the present analysis does not provide descriptions of water supply opportunities.

Unimpaired runoff of the Sacramento River at Bend Bridge, immediately below Shasta Dam ranges from about 3.4 to over 17 maf per year, with an average runoff of about 8.3 maf. Runoff during the winter (January through March) averages in excess of 1.1 maf per month. The existing Shasta Lake typically operates in a storage range of between 2.8 and 4.0 maf over the course of an entire year with extremes of storage from about 0.9 to 4.5 maf. The apparent surplus of water

relative to existing storage regulation would be developed with the added storage consistent with the potential operations strategies being investigated in other studies.

PRINCIPAL FACILITIES

The principal facilities involved in the Shasta Lake Enlargement are listed on Table 1 and are described briefly below. Both the existing facilities and the proposed modifications are described.

Dams and Associated Facilities

The existing Shasta Dam is a curved concrete gravity structure 602 feet high with a crest length of 3,460 feet. Increasing the dam height by 200 feet to elevation 1,280 would increase the crest length to 5,560 feet (an additional 500 feet on the right abutment and 1,600 feet on the left abutment). Figure 3 shows the elevation and reservoir surface area of the existing and enlarged Shasta Dam and Lake. Figure 4 shows the area-capacity relationships for Shasta Lake.

Cost estimates used in this analysis are based on roller-compacted concrete construction for the extension of the abutments. The addition to the center dam section would be constructed with a 0.6:1 downstream face, a vertical upstream face, and a crest width of about 41 feet. In addition to increasing the height of Shasta Dam, four saddle dams would be constructed. These saddle dams, the locations of which are shown on Figure 2, include:

Dam	Location	Maximum Height
		(feet)
Centimudi	East of dam	120
Bridge Bay (I-5 Crossing)	Pit River arm at I-5	30
Jones Valley	Pit River arm	70
Clickapudi Creek	Pit River arm	90

Spillway and Outlet Works

A new spillway having a crest length of 330 feet would be located in the center of the structure. The spillway would be operated with six radial gates 55 feet wide by 27.5 feet high. The capacity would be limited to 253,000 cfs to remain within the capacity of the existing stilling basin.

Although existing planning reports include river outlet works that match the downstream capacity of 80,000 cfs for emergency release operation, these reports state that the sizing of the river outlet works would have to be reevaluated in future analyses, depending on the Corps of Engineers' findings on alternative flood control criteria. For purposes of this report, the outlet works were sized for a capacity of 190,000 cfs to meet emergency evacuation criteria set by the DWR, Division of Safety of Dams.

Power Facilities

In addition to upgrading the existing power plant penstocks and generators on the right abutment, five additional 20-foot-diameter penstocks and generators would be required to increase the Shasta Dam generation capacity from 539 megawatts to 1,000 megawatts. The additional site would permit existing power operation to continue while construction of the new facility is under way. In order to effectively regulate the added peaking capability, Keswick Dam would be increased by 25 feet and outfitted to increase generation capacity from 75 megawatts to 150 megawatts, although there is some question as to the suitability of the foundation material for raising Keswick Dam at the existing site. The combined increase in generation capacity would be partially offset by inundation of Pit River No. 7 power generating plant, which is owned and operated by Pacific Gas and Electric Company.

TRANSPORTATION RELOCATIONS

Two major transportation facilities, Interstate 5 (I-5) and the Southern Pacific Railroad, would be relocated to accommodate the increased reservoir area for an enlarged Shasta Lake. Figure 2 shows the existing and proposed alignments of these facilities. The cost of these relocations total approximately 35 percent of the total cost of the enlargement project.

Interstate 5

Over 18 miles of the I-5 freeway would be relocated. Four new bridges with a combined length of about two miles and four new interchanges would be required. The most costly component of the bridgework is the Bridge Bay crossing. This bridge would also serve as the railroad relocation and would rank among the world's longest spans for a combined facility.

Southern Pacific Railroad

Over 34 miles of the Southern Pacific Railroad would be relocated. The railroad relocation would require eight new tunnels with a combined length of nearly three miles and six new bridges with a combined length of over two miles. As discussed above for the I-5 relocation, the Bridge Bay crossing would be a significant portion of the relocation costs.

COST ESTIMATE

The cost estimates for the facilities described in the previous sections are based on previous estimates performed by the Bureau of Reclamation. Only items included in the previous estimates are included in the present cost estimate and are expressed in October 1996 dollars. This cost estimate does not include costs for modifying the Shasta Lake Temperature Control Device.

Other items not included in this estimate are environmental documentation, operation and maintenance costs, power costs, reservoir filling costs, and interest during construction.

COST ESTIMATE METHODOLOGY

The two previous cost estimates developed by the Bureau of Reclamation form the basis of this cost estimate. The Bureau of Reclamation cost estimates have been reviewed and adopted for the present cost estimate update. Several items in the previous cost estimates were modified to ensure that current design standards and safety factors were incorporated.

General

The cost estimate for the Shasta Lake Enlargement alternative was determined by escalating the costs provided in the September 1983 Bureau of Reclamation report entitled *Enlarged Shasta Lake Investigation - Preliminary Findings Report* and in the February 1988 Bureau of Reclamation report entitled *Enlarging Shasta Lake Investigation*, Office Report, Appendix 3. The costs were escalated to October 1996 dollars using the Bureau of Reclamation's Construction Cost Trends (CCT) indices. Table 2 provides a detailed breakdown of the estimated costs of the Shasta Lake Enlargement. Table 2 also includes an updated cost estimate for each cost item identified in the previous cost estimates, along with the quantities of the cost item or an indication that the estimated cost has been developed through a lump sum approach. The table also includes the Bureau of Reclamation CCT index for the month and year in which the estimated cost was developed and for October 1966. These Bureau of Reclamation cost indices are used to factor the previous cost estimate to October 1996 dollars. In some instances only a unit cost has been provided, with no cost indices. In these cases, the unit cost has been taken from other sources. The far right-hand column of Table 2 provides the cost reference for each cost item.

Right-of-Way Costs

Right-of-way costs of \$3,500 per acre were used based on actual right-of-way costs for the Los Vaqueros Reservoir project currently under construction and the California-Oregon Transmission Project electrical transmission line. The total project lands that need to be acquired include a buffer around the maximum water surface area. The ratio of total project land to maximum water surface area used in the cost estimate is 1.32 based on data from the 1990 DWR report entitled *Los Banos Grandes Facilities Feasibility Report, Appendix A: Designs and Cost Estimates*.

Outlet Capacity Adjustments

In the event of potential emergency conditions, the outlet works and spillway would be required to evacuate 10 percent of the maximum water depth (72 feet) within 10 days as required by DWR's Division of Safety of Dams. With these criteria, the emergency drawdown flow for the 14.3 million acre-foot Shasta Lake Enlargement alternative is estimated at 4.5 maf over 10 days. The release of the top 30 feet of storage (1.8 maf) through the spillway would vary from 253,000 cfs to zero over three days. Assuming a uniform river outlet release rate over the entire head range yields an estimated required river release capacity of 190,000 cfs to evacuate the full 72 feet within the 10-day period.

The estimated cost for river outlet works sized for 80,000 cfs as listed in the February 1988 report was adjusted for the higher flow requirements (190,000 cfs) using the following empirical equation:

$$\frac{(Cost)_1}{(Cost)_2} = \frac{Q_1^{3/4}}{Q_2^{3/4}}$$

This cost factor formula is typically valid over moderate ranges in capacity; the validity over larger ranges is undetermined. However, because the estimated cost of the outlet works is a relatively low percentage of the total project cost, the impact of any error resulting from utilizing this ratio beyond its valid range is considered to be within the range of the accuracy of the estimate.

Contingencies and Other Costs

All contingencies and engineering, construction management, and administrative factors were selected by historical engineering judgment based on a review of previous studies with similar levels of cost estimation. Contingencies were chosen to be 20 percent, and engineering, construction management, and administration were chosen to be 35 percent. A cost range was developed for the project by subtracting 10 percent from the estimated capital cost for the low end cost and adding 15 percent to the estimated capital cost for the high end. Costs for the initial filling of the reservoirs, interest during construction, and environmental mitigation are not included in this estimate.

PRELIMINARY COST FINDINGS

Costs of enlarging Shasta Dam and its supporting facilities have been updated to an October 1996 basis as described above. Table 3 summarizes estimated costs within selected project categories. Actual dam and power plant reconstruction constitutes nearly 50 percent of the project construction costs. Relocation of transportation systems are slightly more than 35 percent of the construction costs. Nearly half of the transportation relocation costs is for a combined railroad and freeway crossing at Bridge Bay. The total cost of the Shasta Lake Enlargement is estimated to be about \$4.73 billion with a resulting calculated range of costs between \$4.25 and \$5.44 billion.

ENVIRONMENTAL CONSIDERATIONS

This discussion provides a summary of environmental considerations for the Lake Shasta Enlargement. Fish, wildlife, plant, and cultural resources that could be affected by the proposed project have been described, and the extent of the potential impacts has been identified. In general, the information presented in this section was gathered from existing literature, with limited original research. No field work was conducted for this analysis.

WILDLIFE

Enlarging Shasta Lake to 14.3 maf would inundate approximately 30,000 acres of additional terrestrial wildlife habitat within the Shasta-Trinity National Recreation Area and up to 42 miles of additional riparian stream habitat. The project area supports over 200 species of resident and migratory birds, more than 50 species of mammals, and several species of reptiles, invertebrates, and amphibians.

Terrestrial Resources

Lands within the Shasta Lake Enlargement area support a diverse faunal assemblage. Mammals found in the area include black bear, grey squirrels, elk, and black-tailed deer.

The lower elevation areas in the McCloud, Sacramento, and Pit River and Squaw Creek drainage areas provide winter range for deer use. Winter range for elk is available in the McCloud and Pit River peninsulas. One of the more significant results of enlarging Shasta Lake would be the loss of approximately 30,000 acres of deer and elk winter habitat, which represents about 80 percent of the available winter range in the area.

The narrow bands of montane riparian areas provide valuable habitat for numerous wildlife species. These areas are typically cooler, moister, and more diverse and productive than surrounding habitats. This habitat provides cover and food for numerous bird species, such as warbler and vireo, and a variety of shrew species. Herbivores and omnivores that frequent streamside vegetation include towhee, sparrow, and squirrel. Black-tailed deer make extensive use of these habitats for fawning, foraging, and escape cover.

Fishery Resources

Shasta Lake and its tributaries provide habitat for a number of coldwater and warmwater fish species. Representative game fish species include rainbow trout, brown trout, smallmouth bass, green sunfish, channel catfish, white catfish, brown bullhead, landlocked white sturgeon, and landlocked silver salmon. Representative nongame fish species include hard head, Sacramento squawfish, golden shiner, and threadfin shad.

Enlarging Shasta Lake would result in the loss of about 42 miles of stream habitat including a portion of Squaw Creek, six miles of the McCloud River, and 16 miles of the Sacramento River, both designated Wild and Scenic Rivers. Loss of this habitat would adversely affect trout production. Additionally, inundated old mines would create potential water quality problems from mining waste, affecting fisheries both in the lake and downstream.

Sensitive and Listed Fish and Wildlife Species

Several State or federally listed fish species are known to exist within the area of the proposed Shasta Lake Enlargement. According to the California Department of Fish and Game's (CDFG) Natural Diversity Data Base (NDDB) (Version 8/96), five wildlife species that are State or federally listed and seven wildlife species that are either candidates for listing or species designated by CDFG as "species of special concern" are known to exist in the project area. Also,

the U.S. Fish and Wildlife Service (USFWS) has identified 22 wildlife species that are federal candidates for listing and six federally listed wildlife species that could potentially be affected by the proposed project.

Based on NDDDB records, listed wildlife species known to occur in or near the project area include Shasta salamander (State threatened), rough scalpin (State threatened), bald eagle (federal Threatened/state endangered), northern spotted owl (federal threatened), and California wolverine (State threatened). Additional species identified by the USFWS include American peregrine falcon (federal endangered), winter-run chinook salmon (federal endangered), Delta smelt (federal threatened), Shasta crayfish (federal endangered), vernal pool fairy shrimp (federal threatened), and valley elderberry longhorn beetle (federal threatened).

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG and that could be affected by the proposed enlargement of Shasta Lake include tailed frog (federal candidate/CDFG species of special concern), foothill yellow-legged frog (federal candidate/State species of special concern), hardhead (CDFG species of special concern), northwestern pond turtle (federal candidate/CDFG species of special concern), Shasta sideband snail (federal candidate), Pacific fisher (federal candidate/CDFG species of special concern), and pale big-eared bat (CDFG species of special concern). Additional species identified by the USFWS include California red-legged frog and Sacramento splittail (both proposed federal threatened) and spotted bat, long-eared myotis, fringed myotis bat, Yuma myotis bat, northern goshawk, tricolored blackbird, ferruginous hawk, little willow flycatcher, white-faced ibis, California horned lizard, western spadefoot toad, McCloud River redband trout, green sturgeon, river lamprey, pit roach, longfin smelt, Siskiyou ground beetle, and Trinity Alps ground beetle (all federal candidates).

VEGETATION

Vegetation at the Shasta Lake Enlargement area consists primarily of woodlands (94 percent). The woodlands are comprised mostly northern yellow pine forest, Sierra montane forest, and blue oak-grey pine forest. Riparian vegetation occurs along the numerous rivers and streams in the area and account for approximately 4 percent of the area that would be affected by the proposed enlargement. Approximately 2 percent of the area affected by the enlargement has been physically altered.

The riparian communities along the rivers and streams of the area are classified as montane. They differ from valley foothill communities because the floodplain is constricted to narrow canyon bottoms that limit river meandering and the lateral extent of the floodplain aquifer. The multilayered vegetation is nearly continuous along the bank, with Fremont cottonwood, white alder, willows, western sycamore, and Oregon ash prevailing as common canopy species. A relatively dense shrub layer of willows, buttonbrush, spicebush, creek dogwood, mule fat, and poison oak are typical. Because of its proximity to adjacent woodlands and forest, dogwood, canyon live oak, Douglas fir, and incense cedar are often intermixed.

Sensitive and Listed Plant Species

To date, no federal- or State-listed plant species have been recorded in the proposed lake enlargement area.

Several plant species or plants that are candidates for federal or State listing are found in the area. According to DFG's NDDDB records, candidate plant species for federal listing that may occur in the project area include silky crypantha, Scott Mountain phacelia, Bellinger's meadowfoam, and Henderson's bent grass. Another candidate plant that has been identified by the USFWS as possibly being affect by an enlarged Shasta Lake is the thread-leaved penstemon.

Two additional plants, Cantelow's lewisia and Shasta snow wreath, listed by the California Native Plant Society as being rare, threatened, or endangered in California and elsewhere, could also be affected by the project.

WETLANDS

Based on wetland information from USFWS's National Wetlands Inventory Maps, approximately 13 miles of intermittent streambeds, 17 miles of upper perennial open water, 4 miles of shrub-scrub wetlands, 19 miles of forested wetlands, 17 acres of upper perennial unconsolidated shore, 1 acre of intermittently flooded wetland, and 11 acres of shrub-scrub semipermanent seasonally flooded wetlands are within the area of the proposed enlargement of Shasta Lake.

CULTURAL RESOURCES

There are 335 known archeological sites and 126 ethnographic sites within the area that would be affected by enlargement of Shasta Lake.

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U.S. Geological Survey, National Aerial Photography Program.

U.S. Geological Survey Topographic Maps: Bella Vista; Bohemotash Mountain; Bollibokka Mountain; Devils Rock; Goose Gap; Hanland Peak; Lamoine; Minnesota Mountain; Montgomery Creek; Oak Run; O'Brien; Project City; Roaring Creek; and Shasta Dam.

Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
SHASTA LAKE ENLARGEMENT

	Existing	Enlarged
Reservoir		
Normal Maximum Water Surface Elevation (feet MSL)	1,068	1,270
Maximum Capacity (maf)	4.55	14.3
Maximum Reservoir Area (acres)	30,000	60,500
Main Dam		
Type (Material and Design)	Curved concrete gravity	Curved concrete gravity with roller-compacted concrete
Height (feet)	602	802
Top of Dam (feet MSL)	1,078	1,280
Crest Length (feet)	3,460	5,560
Downstream Face Slope (horizontal on vertical)	0.8:1	0.6:1
Upstream Face Slope (horizontal on vertical)	Vertical	Vertical
Saddle Dams		
Number Required	0	4
Keswick Reregulation Storage		
Normal Maximum Water Surface (feet MSL)	586	611
Spillway		
Invert Elevation (feet MSL)	1,037	1,243
Length (feet)	330	330
Design Flow (cfs)	253,000	253,000
River Outlet Works (Sized for Emergency Release Excavation)		
Design flow (cfs)	80,000	190,000
Power Capacity		
Shasta (MW)	539	1,000
Keswick (MW)	75	150

Table 2
ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT (14.3 MAF ALTERNATIVE)

COST ITEM	QUANTITY	Unit ^a	USBR INDEX JAN. 82 ^b	USBR INDEX OCT. 96	UNIT COST OCT. 96	TOTAL COST JAN. 82 ^b	TOTAL COST OCT. 96	COST REFERENCE
I. Resort Relocation and Land Rights	40,260	AC			\$3,500		\$140,910,000	1
II. Public Recreation Relocation	JOB	LS	144	217		\$108,000,000	\$162,750,000	2, page 18
III. Reservoir Clearing	30,500	AC			\$1,097		\$33,459,000	3, item IV-a
IV. Enlarged Keswick Dam	JOB	LS	153	203		\$40,000,000	\$53,072,000	2, page 18
V. Recreation Facilities	JOB	LS	144	217		\$29,600,000	\$44,606,000	2, page 18
VI. Sacramento River Seepage Mitigation	JOB	LS	144	217		\$44,800,000	\$67,511,000	2, page 18
SUBTOTAL ITEMS I-VII							\$502,308,000	
COST ITEM	QUANTITY	Unit ^a	USBR INDEX APR. 84 or JAN. 85	USBR INDEX OCT. 96	UNIT COST OCT.96	TOTAL COST APR. 84 or JAN. 85 ^b	TOTAL COST OCT. 96	COST REFERENCE
VII. Southern Pacific Railroad Relocation								
Earthwork	JOB	LS	154	219		\$91,500,000	\$130,120,000	4, page 4-45
Railroad	JOB	LS	154	219		\$38,300,000	\$54,466,000	4, page 4-45
Bridges	JOB	LS	155	226		\$53,300,000	\$77,715,000	4, page 4-45
Tunnels	JOB	LS	161	226		\$67,100,000	\$94,190,000	4, page 4-45
VIII. I-5 Relocation								
Earthwork	JOB	LS	154	219		\$57,500,000	\$81,769,000	4, page 4-45
Roadway	JOB	LS	154	219		\$22,700,000	\$32,281,000	4, page 4-45
Bridges	JOB	LS	155	226		\$43,500,000	\$63,426,000	4, page 4-45
Interchanges	JOB	LS	154	219		\$3,750,000	\$5,333,000	4, page 4-45
Land Acquisition	JOB	LS	155	217		\$700,000	\$980,000	4, page 4-45
IX. Bridge Bay Crossing (Combined Hwy & RR)	JOB	LS	155	226		\$345,840,000	\$504,257,000	4, page 4-45
X. Dams and Dikes								
Remove Existing Structures	JOB	LS	155	203		\$8,000,000	\$10,477,000	4, page 4-34
Dam Structure	JOB	LS	155	203		\$464,000,000	\$607,690,000	4, page 4-34
Spillway	JOB	LS	155	203		\$23,200,000	\$30,385,000	4, page 4-34

Table 2
ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT (14.3 MAF ALTERNATIVE)

COST ITEM	QUANTITY	Unit ^a	USBR INDEX APR. 84 or JAN. 85	USBR INDEX OCT. 96	UNIT COST OCT.96	TOTAL COST APR. 84 or JAN. 85 ^b	TOTAL COST OCT. 96	COST REFERENCE
River Outlet Works ^c	JOB	LS	155	203		\$59,746,000	\$78,248,000	4, page 4-34
Powerplant	JOB	LS	160	219		\$372,800,000	\$510,270,000	4, page 4-34
Switchyard	JOB	LS	156	190		\$67,200,000	\$81,846,000	4, page 4-34
Saddle Dikes/Dams	JOB	LS	139	176		\$42,400,000	\$53,686,000	4, page 4-34
SUBTOTAL ITEMS VII-X.							\$2,417,139,000	
SUBTOTAL							\$2,919,447,000	
CONTINGENCIES @ 20%							\$583,889,000	
ESTIMATED CONSTRUCTION COST							\$3,503,336,000	
ENGR., LEGAL, AND ADMIN. @ 35%							\$1,226,168,000	
ESTIMATED CAPITAL COST							\$4,729,504,000	
ESTIMATED CAPITAL COST RANGE								
LOW (-10%)							\$4,256,554,000	
HIGH (+15%)							\$5,438,930,000	

Footnotes:

^aLS=lump sum; AC=acres

^bTotal costs do not include the 25% contingencies which were included in the cost references.

^cThe river outlet works release capacity was increased from 80,000cfs to 190,000cfs to satisfy DWR's Division of Safety of Dams emergency release requirements. Costs for the river outlet works were factored by the ratio of the capacities to the 3/8 power.

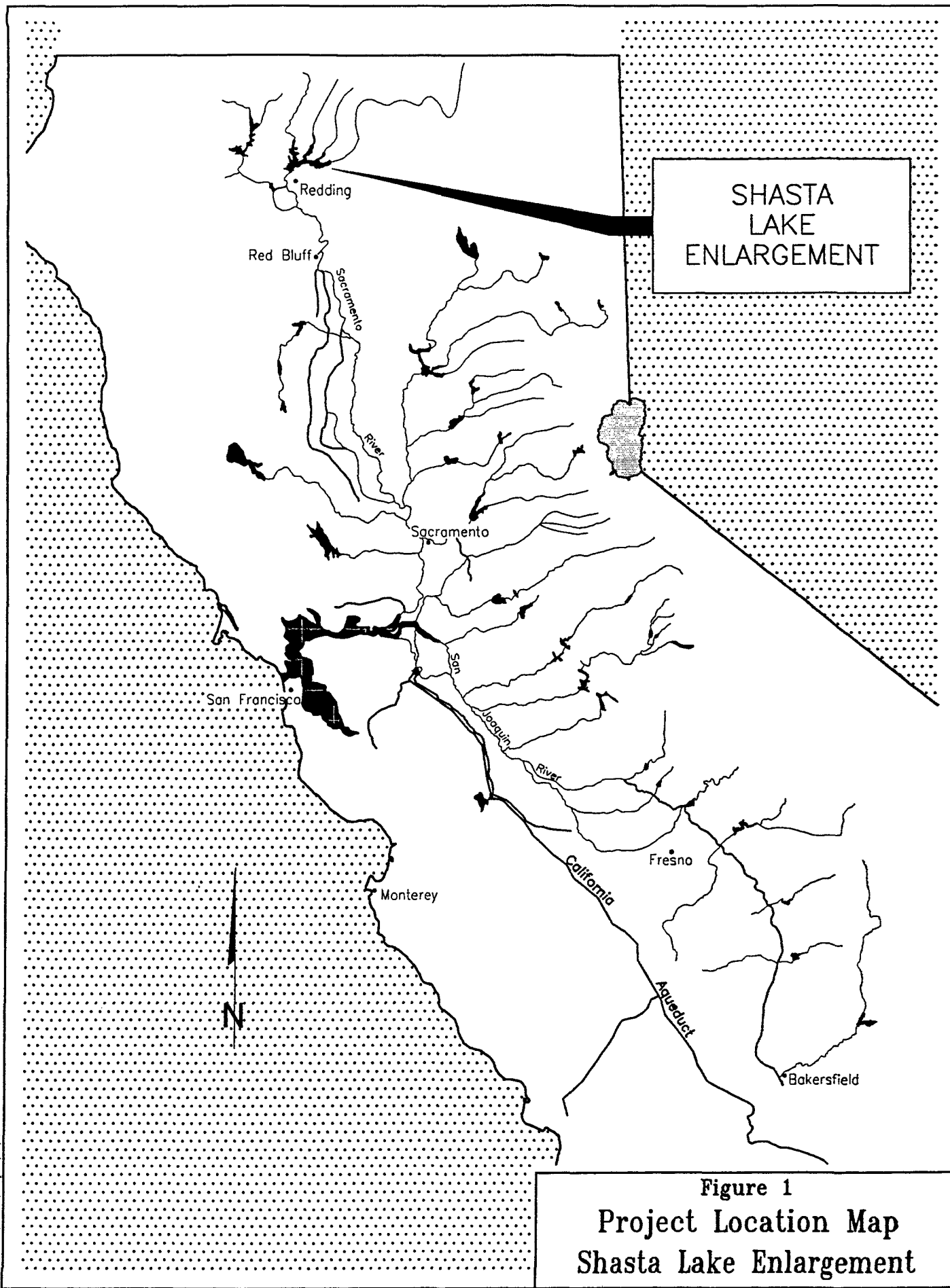
Cost References:

1. Cost developed by Bookman-Edmonston Engineering.
2. U.S. Bureau of Reclamation, *Enlarged Shasta Lake Investigation*, September 1987.
3. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, December 1990.
4. U.S. Bureau of Reclamation and California Department of Water Resources, *Enlarging Shasta Lake Investigation*, Office Report, Appendix 3, February 1988.

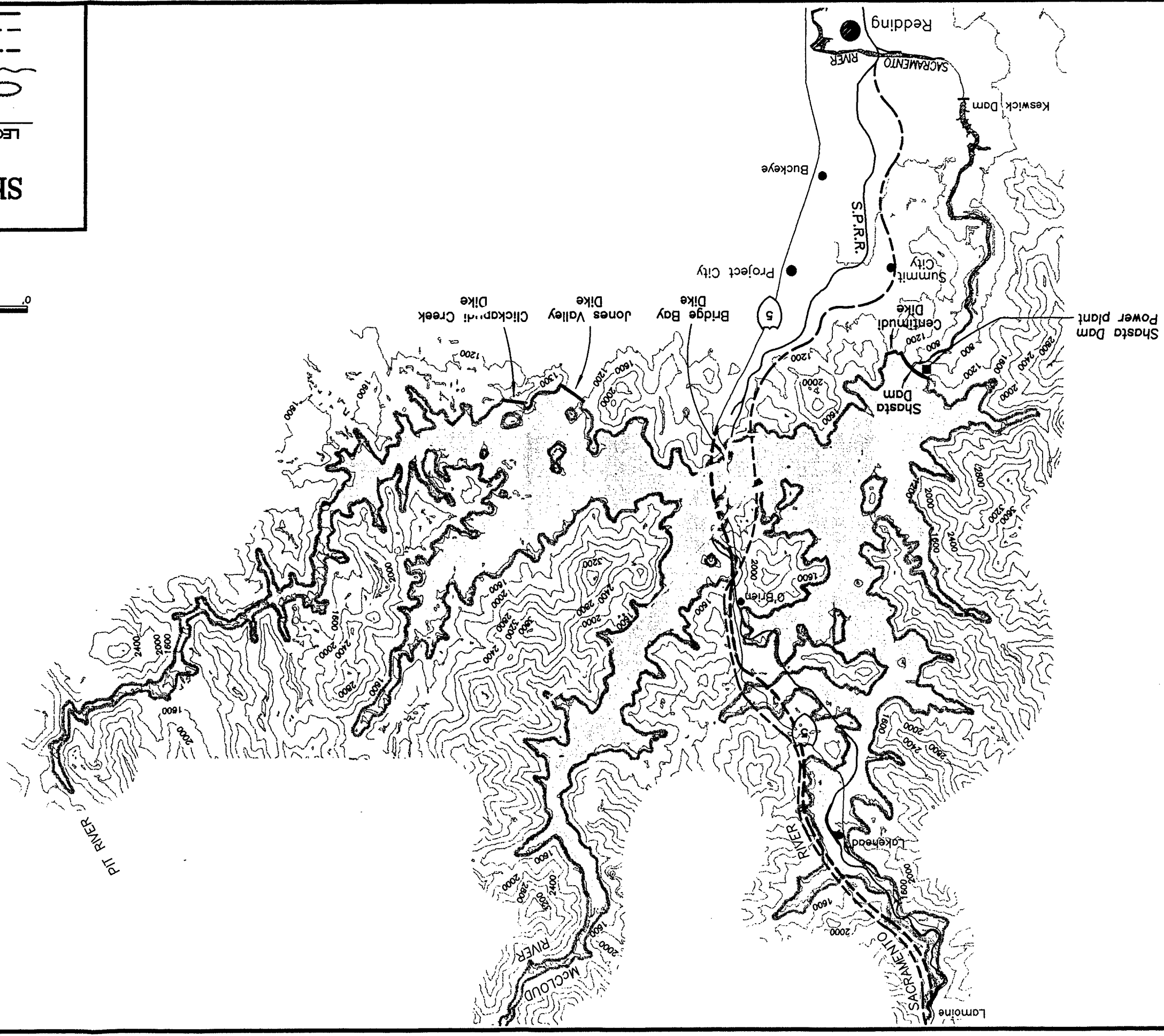
Table 3
SUMMARY OF ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT

Cost Item	Estimated Cost (\$ Millions)
Recreation and Resort	\$348
Reservoir Clearing and River Seepage Mitigation	101
Transportation Relocations	
Interstate 5	184
Southern Pacific Railroad	356
Combined I-5 and Southern Pacific Bridge	504
	1044
Dams and Appurtenances	
Main Shasta Dam	618
Saddle Dams	54
Keswick Dam	53
Outlet Works and Spillway	109
Power Plant and Switchyard	592
	1426
SUBTOTAL	2919
Contingencies (20%)	584
ESTIMATED CONSTRUCTION COST	3503
Engineering, Legal, and Project Administration (35%)	1226
ESTIMATED CAPITAL COST	4729
Capital Cost Range (minus 10% - plus 15%)	\$4,250 - \$5,440

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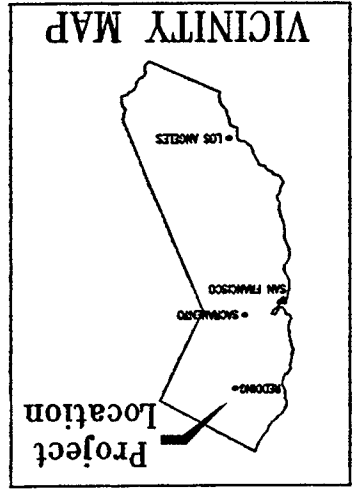
CALFED
BAY-DELTA
PROGRAM



- LEGEND
- Existing Shasta Reservoir (4.55 MAF)
 - Enlarged Shasta Reservoir (14.3 MAF)
 - Existing Rivers and Creeks
 - Proposed I-5 Alignment
 - Proposed Southern Pacific R.R. Alignment
 - Proposed Dams/Dikes

Figure 2
Shasta Reservoir
Enlargement

0' 7500' 15000' 30000'



SHASTA LAKE ENLARGEMENT AND RELATED FACILITIES Schematic Profile

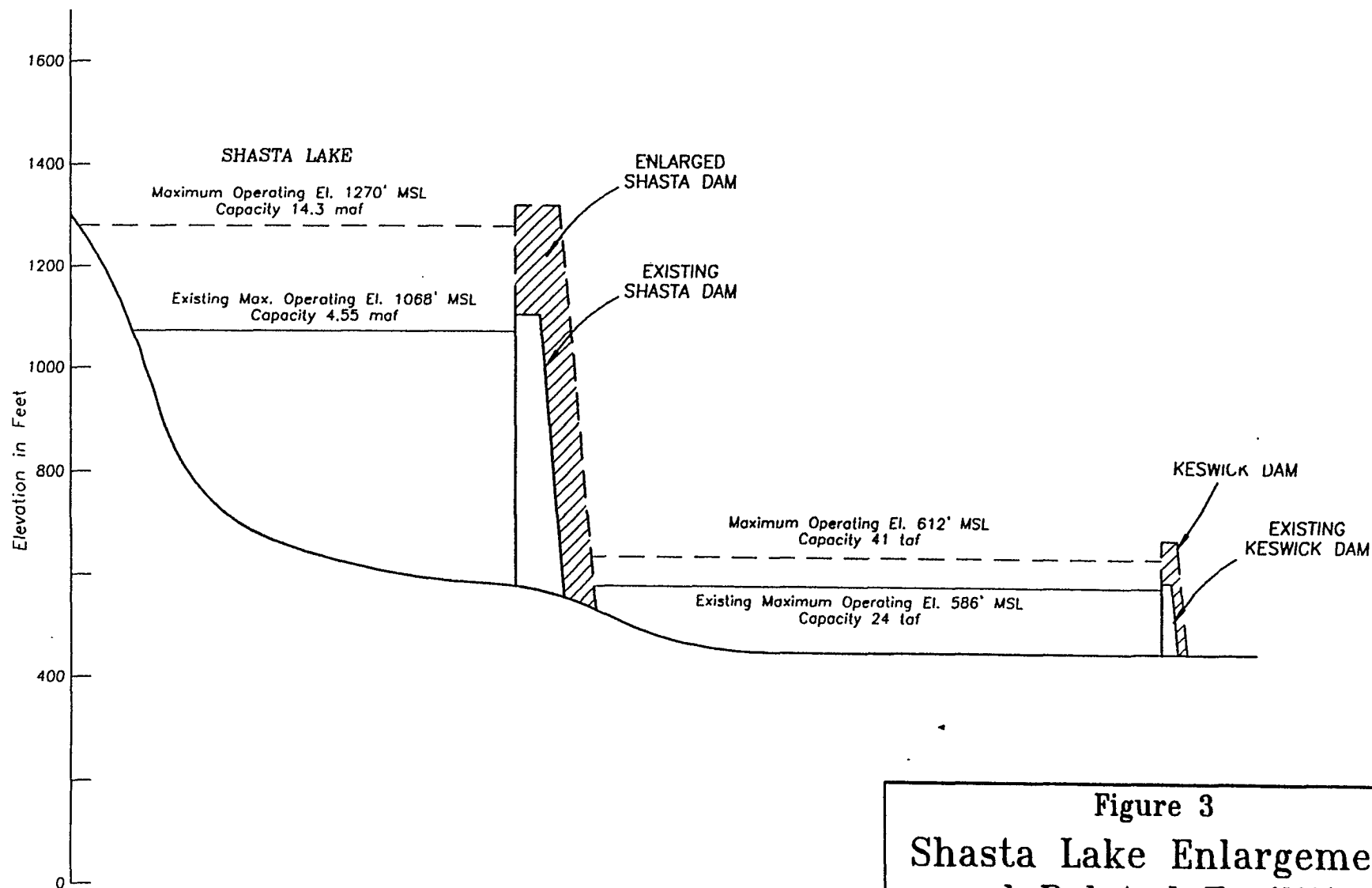


Figure 3
Shasta Lake Enlargement
and Related Facilities
Schematic Profile

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Figure 4
AREA-CAPACITY CURVES
SHASTA LAKE ENLARGEMENT

